(12) UK Patent Application (19) GB (11) 2 270 230 (13) A

(43) Date of A Publication 02.03.1994

(21) Application No 9317295.5

(22) Date of Filing 19.08.1993

(30) Priority Data
(31) 04231947 (32) 31.08.1992 (33) JP

(71) Applicant(s)
Shimadzu Corporation

(Incorporated in Japan)

1 Nishinokyo-Kuwabaracho, Nakagyo-ku, Kyoto-shi, Kyoto 604, Japan

(72) Inventor(s)
Hideo Hirose

(74) Agent and/or Address for Service
Reddie & Grose
16 Theobalds Road, LONDON, WC1X 8PL, United Kingdom

(51) INT CL[5]
H04N 3/10

(52) UK CL (Edition M)
H4F FD12X FD27A1 FD27M FD27P FD30E FD83B FJC

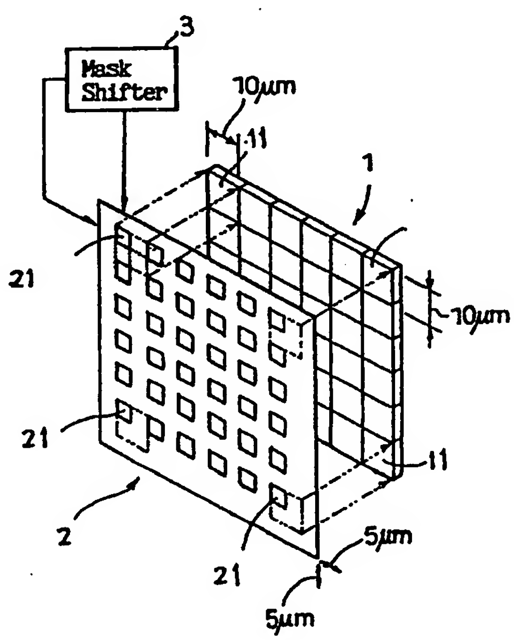
(56) Documents Cited
WO 84/04641 A

(58) Field of Search
UK CL (Edition L) H4F FGY FJB FJC
INT CL[5] G02B 26/10, H04N 3/04 3/10 3/14
Online databases: WPI

(54) Two dimensional image detector

(57) A two-dimensional image detector includes an array sensor 1 having multiple pixels 11 arranged in a matrix. A mask 2 is provided in opposition to a surface of the array sensor on which detection is effected, the mask having windows 21 each having an area smaller than that of each pixel. A mask shifter 3 is provided for changing the positions of the windows at pitches smaller than those between the pixels. The mask may consist of an array of LCD type elements whose polarization is controllable by electrical signals. By correct setting of such signals a series of transmissive window can be produced in the mask and these can then be caused to scan across the sensor array by means of said signals.

Fig. 1



GB 2 270 230 A

Fig. 1

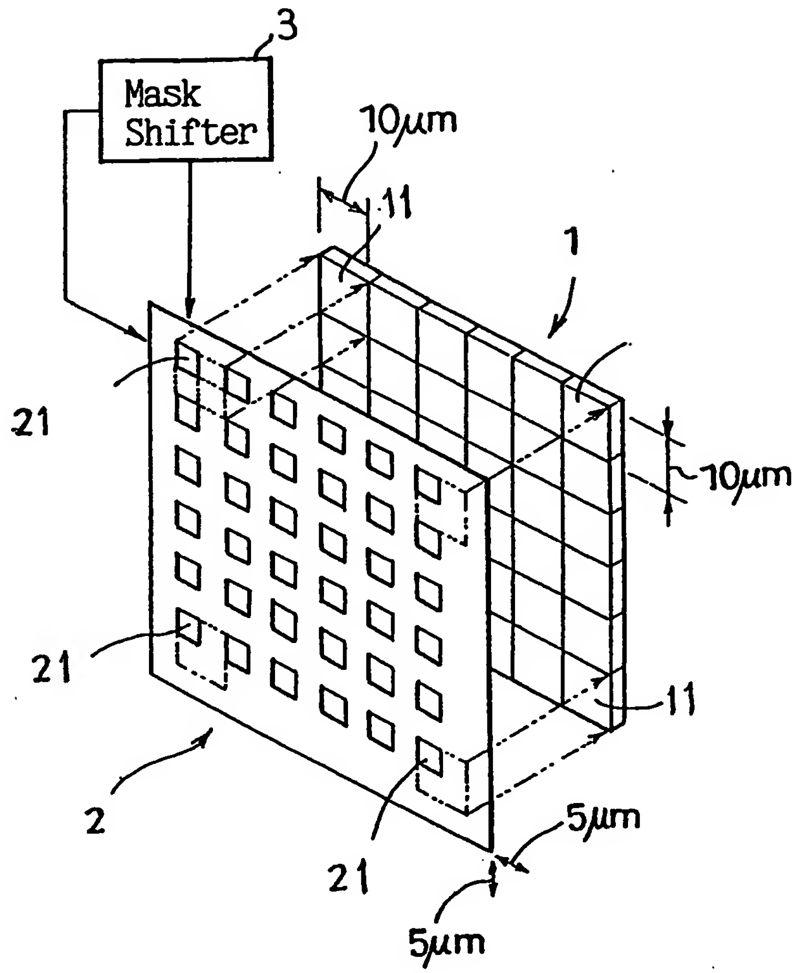


Fig. 2 (a)

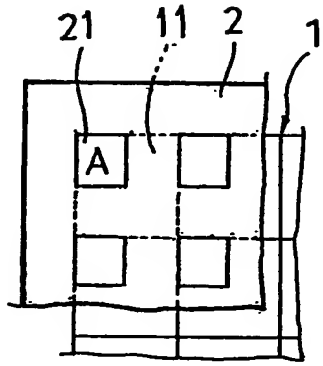


Fig. 2 (b)

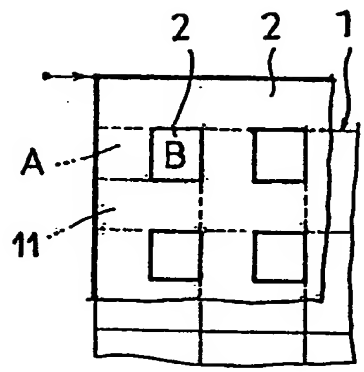


Fig. 2 (c)

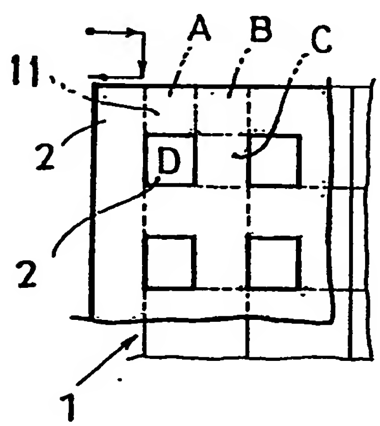


Fig. 2 (d)

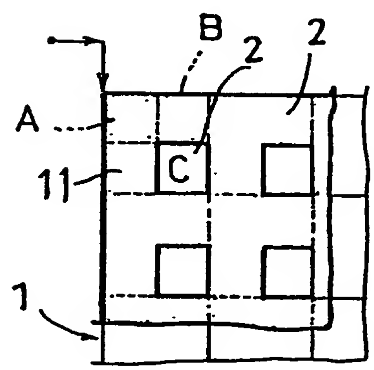


Fig. 3

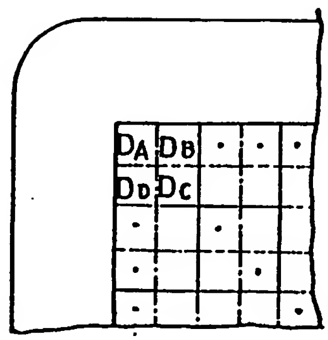
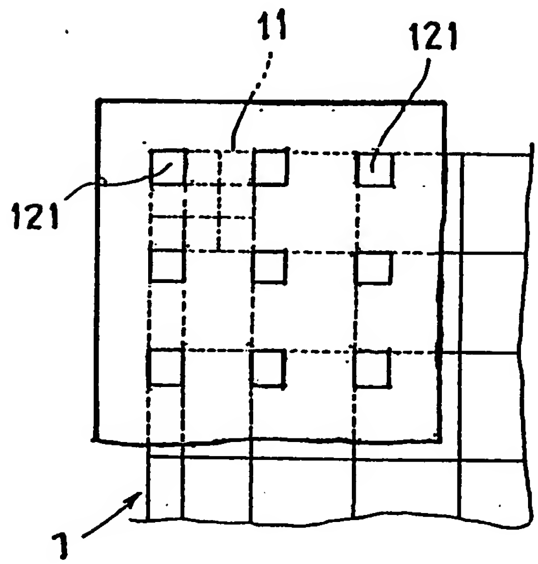


Fig. 4



2270230

TWO-DIMENSIONAL IMAGE DETECTOR

FIELD OF THE INVENTION

The present invention relates generally to a two-dimensional image detector adapted for use in high resolution microscopes such as X-ray microscopes, and charge coupled devices (hereinafter referred to as "CCD") used as electronic cameras.

BACKGROUND OF THE INVENTION

The conventional two-dimensional image detector employs an array sensor consisting of multiple pixels arranged in a matrix, and an electric charge corresponding to light and radiation incident upon each pixel in the array is taken out whereby an electric signal of each pixel is supplied as video information to form an image. This type of two-dimensional image detector is employed in image pickup tubes such as microscopes which form an image by combining signals from divided pixels.

The resolution of a two-dimensional image detector depends upon the size of the pixels. In order to enhance the resolution of the image, it is required to reduce the sizes of pixels but each pixel cannot be subdivided to 10 μm or less because of the working limitation imposed by machines and electrode wiring currently available. As a result, the enhancement of image resolution is limited.

SUMMARY OF THE INVENTION

A two-dimensional image detector according to the present invention comprises an array sensor having multiple pixels arranged in a matrix, a mask provided in opposition to a surface of the array sensor on which detection is effected, the mask having windows each having an area smaller than that of each pixel, and means for changing the positions of the windows at pitches smaller than those between the pixels.

When light passes through the mask window and into each pixel in the array sensor, it is divided into a desired number of subdivisions as the mask changes position, thereby obtaining a group of relatively fine subdivisions. Thus the spatial resolution

of an image is increased in relation to the size of each pixel.

BRIEF DESCRIPTION OF THE DRAWINGS

This invention may be better understood and its numerous objects and advantages will become apparent to those skilled in the art by reference to the accompanying drawings as follows:

Figure 1 is a diagrammatic view showing the structure of a two-dimensional image detector embodying the present invention;

Figures 2(a), 2(b), 2(c), and 2(d) are views exemplifying the operation of the embodiment of Figure 1;

Figure 3 is a diagrammatic view exemplifying a display obtained by the the embodiment of Figure 1; and

Figure 4 is a diagrammatic view showing another example of the embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Figure 1, an array sensor 1 is a CCD image sensor having pixels 11 arranged in matrix, each having an area of 10 μm X 10 μm.

The array sensor 1 is provided with a two-dimensional lattice-like mask 2 on a surface of the array sensor on which detection is effected, the mask 2 having multiple windows 21 formed in matrix. Light passing through the windows 21 enters each pixel 11 in the array sensor 1. The windows 21 are square in shape having an area of 1/4 that of the pixel. The rows and columns of the windows 21 are determined at the same pitches as those of the pixels 11 so that the windows 21 and the pixels 11 are opposed to each other when the mask 2 is disposed against the array sensor 1.

A mask shifter 3 effects the fine movement of the mask 2 vertically or horizontally or both by a fine distance such as 5 μm. The mask shifter 3 is actuated by a piezoelectric element such as PZT (PLZT). The pixel data is stored in a video memory cell (not shown) position by position in the fine movement of the mask 2.

Referring to Figures 2(a) to 2(d), which shows the steps in a clockwise sequence from 2(a) to 2(d) via 2(c), the two-dimensional image detector is operated as follows:

First, the mask 2 is positioned exactly for the array sensor 1 with the windows 21 thereof being aligned with respective areas

of the pixels 11. At this step a first video data (DA) is obtained as shown in Figure 2(a).

Then, the mask 2 is moved to the right by 5 μm so that each window 21 is aligned with the respective area (B) as shown in Figure 2(b). Subsequently, the step shifts to Figure 2(c) where the windows 21 are aligned with the areas (C). At each step video data (DB) and (DD) are recorded in respective memory cells. Finally the step shifts to Figure 2(d) where the windows 21 are aligned with the areas (D) so as to record a video data (DD).

In this way, the four data (DA) to (DD) are obtained. Then these data are combined and displayed on a cathode ray tube (CRT) (not shown) or any other means, so as to form an entire image on the array sensor 1 as shown in Figure 3. By scanning the mask 2, the spatial resolution is enhanced up to 2/1, that is, 5 μm which is equal to 1/2 the size of each window.

In this example, each area (A) to (D) is irradiated with light for the same period of time. To this end, various known methods are selectively used; for example, a source of pulsed light is used wherein the number of pulses is equalized for the areas (A), (B), (C), and (D).

Since the mask shifter 3 is required to shift the mask 2 in micron order, a piezoelectric element such as PZT (PLZT) is used as an actuator.

In the illustrated embodiment each pixel is divided into four subdivisions but the number of subdivisions is not limited to four. Figure 4 shows an example in which each pixel 11 is divided into nine subdivisions 121. More subdivisions are possible.

As an alternative example, instead of shifting the mask 2, the array sensor I and the mask 2 are joined to each other, and they may be shifted as a unit. This example is advantageous in that a light reception spot of each pixel can be fixed at a most sensitive part such as a central portion. This fixed position remains the same even though the windows are shifted, thereby ensuring that the subdivisions are detected on the same conditions. Thus the resulting image has a homogeneous quality.

In a further embodiment, instead of the mask having fixed windows, a material having polarizing characteristics such as liquid crystal is provided with electrodes disposed in matrix so as to form a lattice-like mask having a pixel matrix. By controlling voltage applied to each pixel, the transmissive windows and non-

transmissive windows are changed from one to another. The transmissive windows are arranged at positions corresponding to the areas (A) to (D) as shown in Figures 2(a) to 2(d). In this example, the mask shifter 3 can be omitted.

The two-dimensional image detector according to the present invention can be not only applied to CCD image sensors but also to microchannel plate (MCP), scintillators, and other radiation detecting array devices which are provided with multiple pixels. The mask can be made of tantalum, copper, and gold, selectively depending upon what the detector and what wavelength is applied to.

According to the present invention, the spatial resolution can be increased by at least one figure with respect to the size of pixels. When the detector of the invention is applied to a high resolution microscope, a nano-level inspection can be achieved.

CLAIMS

1. A two-dimensional image detector comprising an array sensor having multiple pixels arranged in a matrix, a mask provided in opposition to a surface of the array sensor on which detection is effected, the mask having windows each having an area smaller than that of each pixel, and means for changing the positions of the windows at pitches smaller than those between the pixels.

2. The two-dimensional image detector of claim 1, wherein the array sensor is a charged couple device image sensor.

3. The two-dimensional image detector of claim 1, wherein the array sensor is a microchannel plate sensor.

4. The two-dimensional image detector of claim 1, wherein the array sensor is a radiation detecting sensor.

5. The two-dimensional image detector of claim 4, wherein the radiation detecting sensor is a scintillator.

6. The two-dimensional image detector of claim 4, wherein the mask is made of tantalum.

7. The two-dimensional image detector of claim 4, wherein the mask is made of copper.

8. The two-dimensional image detector of claim 4, wherein the mask is made of gold.

9. The two-dimensional image detector of claim 1, wherein the means for changing the positions of the windows is a fine mask shifter.

10. The two-dimensional image detector of claim 9, wherein the fine mask shifter comprises an actuator of piezoelectric element.

11. A two-dimensional image detector comprising an array sensor having multiple pixels arranged in a matrix, a mask joined to the array sensor, the mask having windows each having an area smaller than that of each pixel, and means for effecting the fine unitary movement of the array sensor and mask along the surface of the array sensor on which detection is effected.

12. The two-dimensional image detector of claim 11, wherein the shifting means comprises an actuator of piezoelectric element.

13. The two-dimensional image detector of claim 1, wherein the mask comprises electrodes arranged in a matrix on a substance having polarizing characteristics so that a matrix of pixel subdivisions are formed for each pixel in the array sensor, the subdivisions being selectively made transmissive or non-transmissive by controlling an applied voltage.

14. The two-dimensional image detector of claim 13, wherein the substance having polarizing characteristics is liquid crystal.

15. A two-dimensional image detector comprising an array sensor having multiple pixels arranged in matrix, a mask provided in opposition to a surface of the array sensor on which detection is effected, the mask having windows each having an area smaller than that of each pixel, a mask shifter for changing the positions of the windows at pitches smaller than those between the pixels, and a source of pulsed light, the number of pulses being equalized for all the windows of the mask each time the mask is shifted so as to change the positions of the windows with respect to the surface of the array sensor on which detection is effected.

16. A two-dimensional image detector comprising an array sensor having multiple pixels arranged im matrix, a mask joined to the array sensor, the mask having windows each having an area smaller than that of each pixel, a mask shifter for changing the positions of the windows at pitches smaller than those between the pixels, and a source of pulsed light, the number of pulses being equalized for all the windows of the mask each time the mask is shifted so as to change the positions of the windows with respect to the surface of the array sensor on which detection is effected.

17. A two-dimensional image detector substantially as herein described.

Patents Act 1977
Examiner's report to the Comptroller under Section 17
(The Search report)

Application number
GB 9317295.5

Relevant Technical Fields

(i) UK Cl (Ed.L) H4F (FJB, FJC, FGY)

(ii) Int Cl (Ed.5) H04N (3/04, 3/10, 3/14); G02B (26/10)

Search Examiner
J M McCANN

Date of completion of Search
22 OCTOBER 1993

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) WPI

Documents considered relevant following a search in respect of Claims :-
1,11,15,16

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages	Relevant to claim(s)
A	WO 84/04641 (L KING) - see abstract	1,11,15,16

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).